Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Pd: \_\_\_\_\_

**Patterns & Expressions: Tables and Equations**

**Goal:**  Look for connections between the picture, table and equation of a pattern. Identify the rate of change and zero value in a pictures, tables and equations. Use rate of change and zero value to write an equation of a function.

**Toothpick Function 1:** Count toothpicks.

Step 3

Step 2

Step 1

Let ***n*** represent the **step number**.

Let ***t*** represent the number of **toothpicks** needed to build each step.

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (name the dependent variable) depends on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (name the independent variable).
2. Complete the table of values. For step ***n***, if you know a rule for the function, write it on the table. If not, leave the cell below n blank for now.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **n**  **(step #)** |  | 1 | 2 | 3 | 4 | 5 | … | 10 | … | 50 | … | n |
| **t (toothpicks)** |  |  |  |  |  |  |  |  |  |  |  |  |

(If you were unable to determine values for step 10 and step 50, you may leave them blank for now.)

1. Is the Toothpick Function 1 linear? \_\_\_\_\_\_ **Explain** how you know.
2. What is the **rate of change** for the Toothpick Function 1?\_\_\_\_\_\_

Using a blue pencil, mark the rate of change in the picture.

Using a blue pencil, mark the rate of change in the table.

1. What is the **zero step** for the Toothpick Function 1 (i.e. how many toothpicks would you need to build a figure that would come ***before*** step one)? \_\_\_\_\_\_

Using a red pencil, mark the zero step in the picture.

Using a red pencil, add the zero step to the table of values.

Once you know a function’s rule, you can determine **t** (toothpicks) for any value of **n** (step number), no matter how large. Using extended table, like the one below, can be a good way to start using mathematical operations (+, -, ÷, x) to describe how a function changes.

|  |  |  |  |
| --- | --- | --- | --- |
| **Toothpick Function 1** | | | |
| n | t -expanded | t –simplified | t |
| 0 | 1 |  | 1 |
| 1 | 1 + 2 |  | 3 |
| 2 | 1 + 2 + 2 |  | 5 |
| 3 | 1 + 2 + 2 + 2 |  | 7 |
| 4 |  |  |  |
| 5 |  |  |  |
| 10 |  |  |  |
| 50 |  |  |  |
| n |  |  | t |

1. **Analyze** the **t-expanded** column in the table above.
   1. How do you see the **rate of change** in the t-expanded column?
   2. How you see the **zero step** in the t-expanded column?
   3. **Complete the values** for step 4 and step 5 in the **t-expanded** column and in the **t** column. (***Do not*** *complete the t-simplified column yet.*)
   4. Describe what you think step 50 would look like in the t-expanded column. (*You do not need to complete step 10, step 50 or step n in this column.*).
   5. Can you think of a more efficient strategy to calculate step 50? Describe your strategy.

On the previous page, you used **repeated addition** in the **t-expanded column** to describe how the Toothpick Function changes. However, repeated addition is not a very efficient way of finding missing values in a table. Repeated addition can also be written as multiplication. This means that 5 + 5 + 5 can also be written as 5(3).

1. Rewrite the following expressions using multiplication.
   1. 5 + 5 + 5 + 5
   2. x + x + x
   3. 2 + 2 + 2 + 2 + 5
   4. 6 + d + d + d
2. Complete the **t-simplified column** by **using multiplication** to simplify the repeated addition expressions in the t- expanded column. Use the pattern that you discover to write a rule for the function in the row for **Step n**.

|  |  |  |  |
| --- | --- | --- | --- |
| **Toothpick Function 1** | | | |
| n | t - expanded | t –simplified | t  Hint: You may want to wait to complete Step 0 and Step 1 until you have completed Steps 2-5. Steps 0 & 1 should follow the same pattern as all the others. |
| 0 | 1 |  |  |
| 1 | 1 + 2 |  |  |
| 2 | 1 + 2 + 2 |  |  |
| 3 | 1 + 2 + 2 + 2 |  |  |
| 4 |  |  |  |
| 5 |  |  |  |
| 10 |  |  |  |
| 50 |  |  |  |
| n |  |  | t |

1. Write your rule for the Toothpick Function as an **equation** here: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   1. Using a blue pencil, circle the **rate of change** in your equation.
   2. Using a red pencil, circle the **zero step** in your equation.
2. Explain what information each number and variable in your equation represents.
3. Why is multiplication used to show the rate of change in the equation of a linear function?
4. How many toothpicks would be needed to build the following steps? (Show work!)
5. Step 45
6. Step 100
7. Step 3000